News

EARTH & ENVIRONMENT

Ice cliffs may not boost sea level rise

Contribution of collapsing glacial walls was overestimated

BY CAROLYN GRAMLING

Calving of Greenland glaciers (icebergs from Jakobshavn shown) may not be a good proxy for calculating the effects of ice cliff collapse in Antarctica.

Sea level rise over the next century won't get a feared boost from Antarctic ice cliffs crumbling into the ocean like dominoes, a new study suggests.

The finding, published in the Feb. 7 *Nature*, is based on a statistical analysis showing that such a rapid collapse of ice cliffs in Antarctica was extremely unlikely to have happened in the past, even during some of Earth's warmest episodes over the last 3 million years.

The study, by climate scientist Tamsin Edwards of King's College London and colleagues, counters a controversial hypothesis that suggests rising greenhouse gas emissions could destabilize those cliffs and help send sea levels surging by over 2.1 meters by 2100. That figure is nearly double some sea level rise projections for the end of the century.

How quickly global warming is causing ice sheets in Greenland and Antarctica to melt is one of the most urgent questions related to future sea level rise.

Some scientists fear that melting could speed up dramatically sometime in the future, thanks to a possible feedback loop known as marine ice cliff instability. The hypothesis was described in 2016 by geoscientist Robert DeConto of the University of Massachusetts Amherst and paleoclimatologist David Pollard of Penn State. Using computer simulations of the mechanical and structural properties of ice, the pair suggested that ice cliffs at the edges of glaciers that jut into the sea are a dramatically underestimated source of future sea level rise (*SN: 4/30/16, p. 13*).

"Ice that flows into the ocean essentially always ends in a cliff," DeConto says. "Basic physics tells us that very tall cliffs, extending 100 meters or more above the water surface, will begin to produce stresses in the ice that can exceed its strength." When that happens, the ice breaks, and giant blocks tumble into the sea. The collapse of such cliffs would create new cliffs behind them that would tumble as well, in a kind of domino effect.

But scientists have questioned the applicability of that hypothesis because there are currently no such giant ice cliffs to observe. Antarctica's glaciers are buttressed from below by floating ice shelves that help support the weight, although that could change as global warming erodes ice shelves. To model ice cliff behavior, DeConto and Pollard used the brittle breaking and speedy retreat of Greenland glaciers that lack ice shelf buttresses, though these ice cliffs aren't as tall as Antarctica's.

One reason the hypothesis was controversial is that there are uncertainties about the progression and effects of such cliff collapse, Edwards says. Would all the blocks end up in the sea? How much surface melting of the ice would there be, and how would that meltwater speed the fractures along? "We would all agree that ice cliffs might have a maximum height and above that they're unstable, that the strength of ice has a limit," Edwards says. But the question is how that translates to sea level rise.

To figure out whether an ice cliff feedback might have happened and contributed to sea level rise in the past, Edwards and colleagues ran a statistical analysis of DeConto and Pollard's simulation. The researchers focused on three time periods: the mid-Pliocene warm period about 3.3 million to 3 million years ago; the last interglacial period 130,000 to 115,000 years ago; and 1992 to 2017, the period for which there are satellite data of the rate of ice mass loss.

The original simulation included only about 64 iterations. Edwards' team, however, mapped out statistically how the simulation would respond in 10,000 different iterations by changing parameters from the estimated rate of atmospheric warming to estimated past sea level rise. The ice cliff collapse hypothesis wasn't needed to reproduce any of the sea level changes during the three time periods.

DeConto says he's happy that researchers are testing the ice cliff instability theory. "The fact that folks are pushing back is a good thing," he says. The new study, he adds, highlights the usefulness of statistically analyzing many possible outcomes for a simulation.

Meanwhile, he, Pollard and colleagues presented an updated version of their simulation in December at the American Geophysical Union annual meeting. Their findings support the new conclusion that ice cliff instability won't double sea levels by 2100 because the instability hasn't really kicked in yet. But if greenhouse gas emissions continue unabated, the researchers said, by 2200 ice cliff collapse could help bump up sea level by up to four meters compared with 2000. ■

BRENDAN DELANY/SHUTTERSTOCK